

## ELECTRICAL CONNECTION FOR FUEL INJECTORS

### **CROSS REFERENCE TO RELATED APPLICATIONS**

[1] This application claims priority to U.S. Provisional Application No. 60/242,873, which was filed on October 24, 2000.

### **BACKGROUND OF THE INVENTION**

[2] This invention generally relates to fuel injectors for use with internal combustion engines. More particularly, this invention relates to an electrical connection arrangement for such fuel injectors.

[3] Fuel injectors are typically included as part of the arrangement for providing fuel to an internal combustion engine. Fuel injectors take a variety of forms but typically include at least some electronic components that require electrical power and/or signals for proper operation. Typical arrangements include wire harnesses and standard connectors for coupling the fuel injector components to a power source and other control devices on the vehicle.

[4] There are a variety of problems associated with the conventional connection methods used for fuel injectors. Typical connectors include a plurality of male pins associated with the fuel injector and a cooperating set of female pins associated with a connector. The connector typically has an outer shell which facilitates making the connection. During assembly, however, it is not uncommon for some of the male or female pin portions to become bent or distorted. The typical connector housing shields these pins from view so that visual inspection of a proper connection is not possible. Additionally, conventional connection arrangements do not always provide a secure connection over time.

[5] This invention provides an improved connection arrangement that facilitates more secure electrical and physical connections for coupling a fuel injector to other electrical components on a vehicle. This invention provides the advantages of a more secure connection, visual inspection capabilities, simplified manufacturing procedures and material cost savings.

## **SUMMARY OF THE INVENTION**

[6] In general terms, this invention is a fuel injector assembly that includes a body portion that houses the fuel injector components. An electrical interface portion is supported by the body portion. At least one deformable connector member is supported on the interface portion. The deformable connector member has at least one edge that is adapted to penetrate an insulation covering on an electrical conductor to thereby electrically couple the connector portion to the electrical conductor.

[7] In the preferred arrangement, the conductor is a flex cable and there are a plurality of deformable connector members that are crimped into connection with the conductive part of the flex cable.

[8] The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

[9] Figure 1 schematically illustrates a fuel injector assembly designed according to this invention.

[10] Figure 2 is a partial, perspective, exploded view of selected components of the embodiment of Figure 1.

[11] Figure 3 illustrates the components of Figure 2 in an assembled condition.

[12] Figure 4 is a cross sectional view taken along the lines 4-4 in Figure 3.

[13] Figure 5 illustrates another example embodiment from a cross sectional view.

[14] Figure 6 schematically illustrates machinery for making an electrical connection according to this invention.

## **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

[15] A fuel injector assembly 20 includes a generally conventional fuel injector body portion 22. An electrical interface 24 includes at least one connector member 26 to facilitate electrically coupling selected components of the fuel injector to other devices on

a vehicle, such as an electronic controller and a power source, for example. An electrical conductor 28 permits communication of such electrical signals or power as needed.

[16] The electrical connection interface 24 preferably includes a support portion 30 that receives and supports a portion of the conductor 28 during an assembly process. Once the conductor 28 is positioned relative to the interface 24, the connector members 26 preferably are deformed so that at least one portion of each connector member penetrates through an insulation layer 32 on the conductor 28 and forms an electrical coupling with a conductive portion 34 of the conductor 28. In the illustrated example, the connector members 26 are barbs with pointed edges that pierce through the insulation layer 32 and engage the conductive portion 34. In the illustrated arrangement, it is preferred to crimp the connector members 26 into the position shown in Figure 4, for example, where a secure physical and electrical connection has been made between the interface 24 and the conductor 28.

[17] Once an appropriate connection has been made, it is preferred to include a covering over at least a portion of the connecting interface 24 and an associated portion of the conductor 28. Figure 5 illustrates an example covering 50, which preferably covers over the entire connecting interface 24 and an associated portion of the conductor 28. In one example, the covering 50 is molded plastic that is applied after the appropriate electrical connection has been made. In another example, the covering 50 is a seal that is applied to not only cover over the connecting interface 24 but also to provide a seal along the associated region of the fuel injector body 22 to prevent any contaminants from entering an opening in the body portion 22 adjacent the interface 24. Other example coverings 50 include foam or silicone type materials. The purpose of the covering 50 is to prevent wear or deterioration over time due to environmental exposure.

[18] Figure 6 schematically illustrates machinery 60 for holding a fuel injector in place during the assembly procedure according to this invention. Crimping members 62 preferably move as shown by the arrow 64 into position to deform the connector portions 26 into a position where a proper electrical and physical coupling is made. In the illustrated example, the crimping members 62 crimp the barb portions 26 into a position as shown in Figure 4, for example.

[19] The preceding description is exemplary rather than limiting in nature. For example, a single conductor with a plurality of connector members has been illustrated. Of course, this invention is applicable to fuel injector arrangements having multiple electrical conductors that are coupled with fuel injector components. Each conductor member may include a plurality of connector members, but at least one is preferred. Other variations and modifications to the disclosed example may become apparent to those skilled in the art that do not necessarily depart from the essence of this invention. The scope of legal protection given to this invention can only be determined by studying the following claims.